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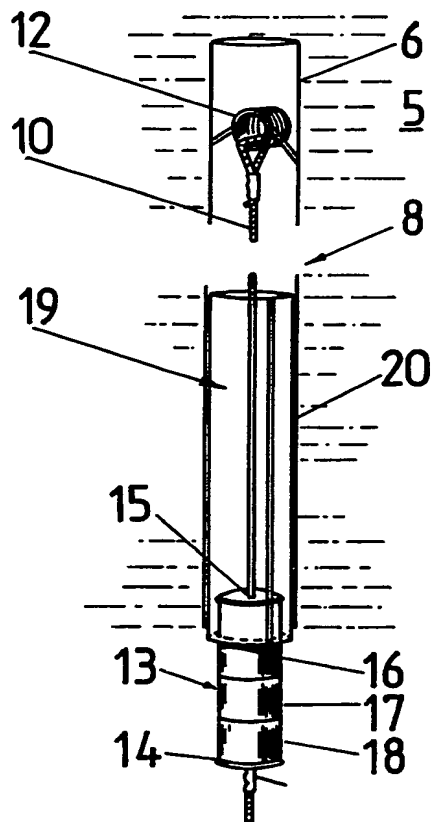
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**G1S SCF SCJ**  
**G1M MCCH M11H M12E**  
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(56) Documents cited  
**GB 1453260 A** **GB 1318344 A** **US 4514905 A**  
**US 3538608 A**

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**UK CL (Edition J) G1M, G1S**  
**INT CL<sup>4</sup> G01B**  
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(54) **Strata movement indicator**

(57) A strata movement indicator 8 includes a length of wire 10 having at one end a torsion-spring anchor 12 and at the other a cylinder 14 constituting the indicator element 13 which has three colour bands 16, 17, and 18. The cylinder is moveable within a split guide tube 20 which in use is fixed in the outer margin of a borehole 6. Progressive obscurement of the colour bands is indicative of increasing degrees of strata movement.



**FIGURE 2**

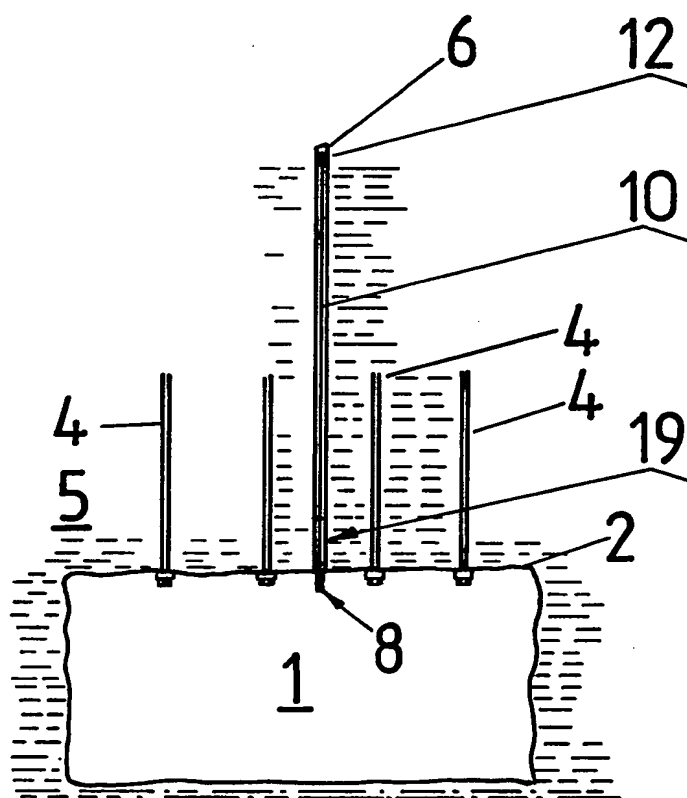


FIGURE 1

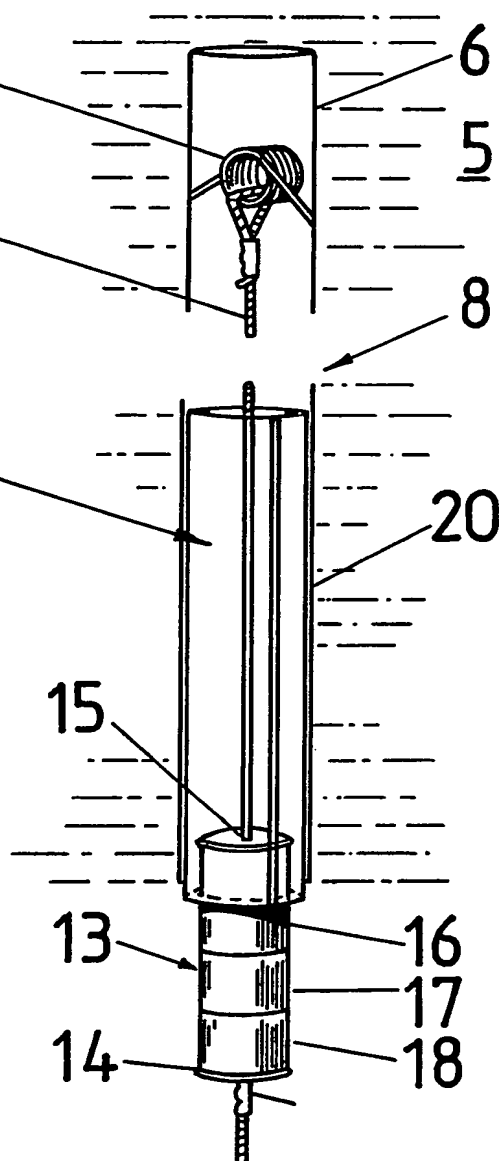


FIGURE 2

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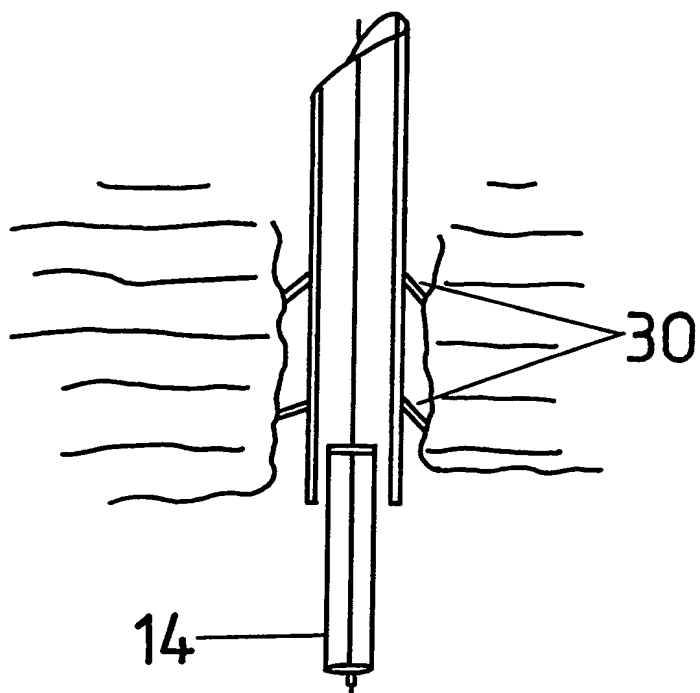
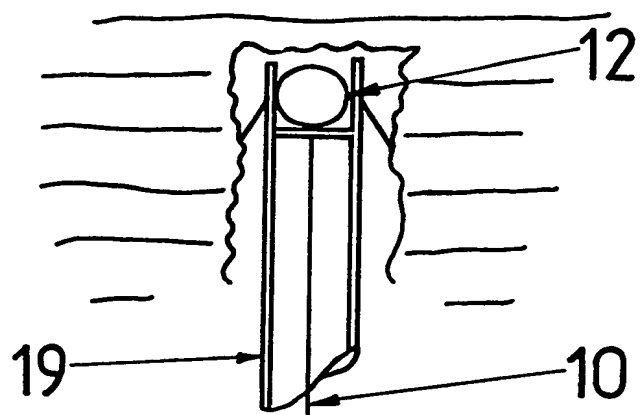


FIGURE 3

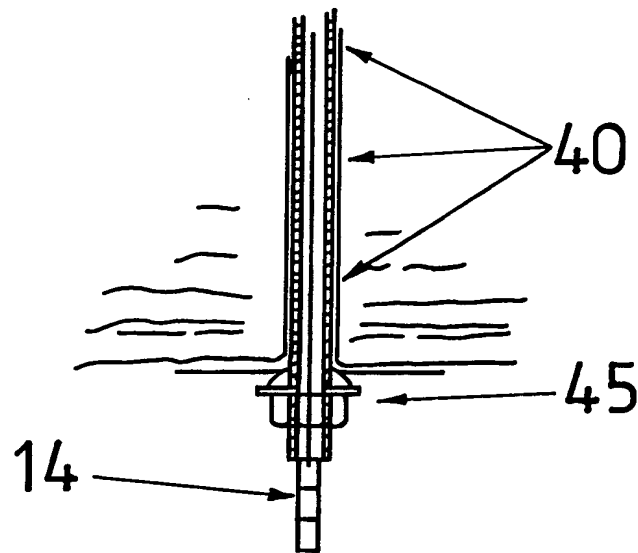
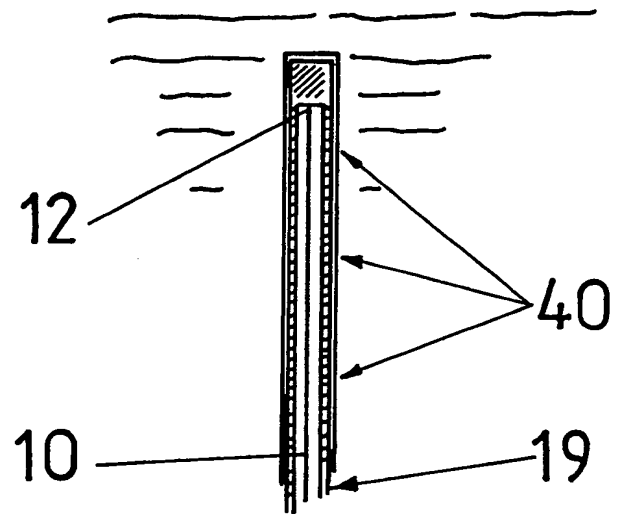


FIGURE 4

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STRATA MOVEMENT INDICATOR

This invention concerns a strata movement indicator.

The present invention has particular, but not exclusive, reference to an indicator for use in underground mines, for example coal mines, in association with rock bolted strata.

- 5 The rock bolting of strata defining roadways or galleries in underground mines has long been known and applied, dependent upon the nature of the strata and the method of working the mineral seams. Although it has found widespread application for example in the United States, it has not been until more
- 10 recent times that it has found favour in the United Kingdom and Europe where more conventional supports, for example arches, have predominated. By virtue of their distortion or displacement, such supports give a readily observable indication as to the manner in which movement within the
- 15 surrounding strata is taking place.

However, when employing rock bolts alone for reinforcement, because they are embedded within the strata there is no readily external visual indication as to the movement of the strata.

- 20 An object of the present invention is therefore to provide a strata movement indicator of simple and yet effective construction.

- According to the invention a strata movement indicator includes a flexible elongate suspension member, an anchor for
- 25 anchoring the suspension member in use within a borehole formed in the strata, a guide through which the member passes, the guide being fixable in use within the borehole, and an indicator element held on the suspension member and movable in relation to the guide, the movement of the element being indicative of strata movement.

The flexible elongate suspension member may conveniently be a length of wire cable, and the anchor may be a wire torsion spring engageable directly with the wall of the borehole.

5 The wire cable may be affixed to the anchor which in turn may be secured to the end of the guide. In this case, the guide extends substantially the whole length of the borehole, the guide being provided with fixing anchors at its other end for engaging the relatively outer margin of the borehole.

10 In an alternative embodiment with the guide extending substantially the whole length of the borehole, the guide may be formed with points of weakness, whereby in use upon the action of strata movement, failure occurs. The points of weakness may be created by relieving the wall of the guide at spaced intervals along its length, for example by generating a  
15 castellated or saw-tooth pattern. Alternatively, the guide could be produced from a ribbon of material wound in helical fashion to form a tube. In this embodiment, the guide may be secured by resin within the annular space between the guide and the wall of the borehole.

20 In an alternative embodiment, the guide may be a relatively short tubular sleeve extending in use a short distance within the borehole and being split longitudinally affording a spring effect, whereby the sleeve may be sprung into the borehole and frictionally fixed therein.

25 The guide may in one embodiment of the strata movement indicator be fixable within an relatively outer margin of the borehole.

The indicator element may be cylindrical in form and slidable in the manner of a piston within the guide. The indicator  
30 element is preferably marked to indicate the degree of extension/retraction thereof within the guide and thus the degree of strata movement. The marking may be achieved by the use of chromatic banding, conveniently the colours being red, orange, and green to represent the degrees of strata

movement, red being indicative of a potentially dangerous condition in which urgent and substantive action is required to avoid failure of the roadway, green representing an acceptable condition, and orange indicating an interim  
5 condition in which moderate remedial action needs to be taken.

By way of example only, three embodiments of strata movement indicator according to the invention are described below with reference to the accompanying drawings in which:

10 Figure 1 is a schematic representation of a roadway in which strata bolting has been effected and a first embodiment of the indicator of the present invention has been installed;

15 Figure 2 is a detailed cross-sectional view taken through the indicator of Figure 1 in situ;

20 Figure 3 is a cross-sectional view of a second embodiment of the strata movement indicator; and

Figure 4 is a cross-sectional view of a third embodiment of the strata movement indicator.

Referring to the drawings, there is shown a roadway 1 within  
25 an underground mine, for example a coal mine. The roof 2 of the roadway 1 is illustrated as having been rock bolted, the rock bolts being indicated by the references 4 and being secured in boreholes (not referenced) within the strata 5 by conventional means, for example by resin or other suitable  
30 means which may be of a mechanical nature.

A further borehole 6 is formed within the strata and extends a distance beyond the boreholes for the bolts 4, and accommodates a strata movement indicator shown generally at 8. The indicator 8 includes an elongate flexible suspension  
35 member in the form of a braided steel wire 10 which has at one end a wire torsion-spring anchor 12 and at the other end an indicator element 13 constituted by a steel cylinder 14 held to

the wire 10 by a ferrule 11 crimped thereto at a set position as will hereinafter be described. The cylinder 14 has a central bore 15 and has on its outer surface colour bands, 16, 17 and 18 being respectively green, orange and red.

- 5 A guide 19 is provided and comprises a split tube 20 which in use functions as a reference for the indicator element 13 and is located in the relatively outer margin of the borehole 6.

In practice the strata movement indicator of the present invention is emplaced in the following manner, given that the  
10 borehole 6 has previously been formed in the appropriate location, for example adjacent to a heading in a roadway in which rock bolting has been or is in progress. The split tube 20 is first inserted into the borehole 6 and pressed home to sit firmly within the relatively outer margin of the  
15 borehole 6 partially proud thereof. An insertion rod (not shown) is used to introduce the anchor 12 carried by the wire 10 through the guide 19 and into the borehole 6. With a slight tension on the wire 10 the insertion rod carries the anchor 12 to a position adjacent the inner end of the borehole  
20 6 and there engages the wall of the borehole in sprung frictional fashion.

The cylinder 14 of the indicator element 13 is threaded onto the wire 10 which passes through the central bore 15 until the top of the green band 16 aligns with the bottom edge of the  
25 split tube 20. The ferrule 11 is then crimped to the wire 10 beneath the cylinder 14 to hold the cylinder in that initial position. The date and time of installation of the strata movement indicator are then recorded together with the length of the borehole drilled in order to establish a datum against  
30 which any movement of the strata can be monitored.

As dilation of the strata occurs due inter alia to the working of the mineral seams within the mine environs, the anchor 12 will accordingly move and carry the cylinder 14 further into the split tube 20 thus obscuring the colour bands sequentially  
35 dependent upon the severity and extent of the strata



movement. The colour bands 16, 17 and 18 in this embodiment are 25 mm wide and thus strata dilation of 5mm per metre would for a borehole length of 5 metre be sufficient to conceal the top green band 16. In like manner, the orange band 17 would  
5 be concealed at 10 mm per metre, and the red band 18 at 15 mm per metre.

Regular inspection of the strata movement indicator will readily and simply reveal the condition of the strata and will accordingly dictate the type of remedial action, if  
10 necessary. For example, while the green band remains showing, the degree of strata movement, if any, may be regarded as acceptable. If, however, the green band becomes obscured but the orange band remains in view, action needs to be taken to quantify the extent of strata dilation in more  
15 detail, using adjacent indicators and other instrumentation. The need for remedial action in the form of additional rock bolting in the vicinity of the detected movement may be indicated.

If the orange band becomes obscured and accordingly only red  
20 shows, again, as described above, readings of adjacent indicators and other instrumentation should be taken to quantify the effect and determine what additional support is required.

25 Referring to Figure 3, similar references have been used to denote like parts as those shown in Figures 1 and 2. The second embodiment of strata movement indicator includes a guide 19 which extends when in position within the borehole 6 substantially the whole length of the borehole. One end of  
30 the guide 19 carries the anchor 12 and the other end is provided with fixing anchors 30 for engaging the relatively outer margins of the borehole 6 as shown. The wire 10 is secured to the anchor 12 and carries at its other end the cylinder 14. The advantage of this embodiment is that the  
35 guide being of such a length serves in use to position the anchor 12 in the borehole and remains in situ.

The installation of the strata movement indicator is thus simplified and is swifter.

Referring now to Figure 4, the guide 19 in this third embodiment is formed of a hollow rock bolt and is provided  
5 with a plurality of weak points denoted at 40. The anchor is achieved by resin encapsulation around the guide within the borehole 6. The end of the guide remote from the entry to the borehole constitutes part of the anchor for the wire 10 which carries the cylinder 14. In use the guide is inserted  
10 into the borehole 6 in the manner of a rockbolt, resin being usual to secure the guide within the borehole, the guide carrying a standard nut and washer combination 45 as shown. As the strata move, the weak points in the guide allow it to fail and in so doing the wire 10 pulls with it the cylinder 14  
15 in the manner previously described in relation to the first embodiment, to give an indication of such movement.

One advantage of the third embodiment is that it can be installed in the manner of a rock bolt and in the course of such installation the wire carrying the indicating cylinder is  
20 also anchored in the borehole. A further advantage is that being weak in tension, but otherwise strong, the guide can detect strata movement without resisting it.

The present invention thus provides a simple and yet effective strata movement indicator having an easily readable means for  
25 assessing a change of condition.

BCC P8

CLAIMS

1. A strata movement indicator includes a flexible elongate suspension member, an anchor for anchoring the suspension member in use within a borehole formed in the strata, a guide through which the member passes, the guide being fixable in use within the borehole, and an indicator element held on the suspension member and movable in relation to the guide, the movement of the element being indicative of strata movement.
2. An indicator according to claim 1 in which the flexible elongate member is a wire cable.
- 10 3. An indicator according to claim 1 or 2 in which the anchor comprises a wire torsion-spring.
4. An indicator according to any one of the preceding claims in which the indicator element is in the form of a cylinder slidable within the guide.
- 15 5. An indicator according to any one of the preceding claims in which the indicator element is provided with chromatic banding on its exterior surface.
6. An indicator according to any one of the preceding claims in which the guide is a tubular sleeve split longitudinally.
- 20 7. An indicator according to any one of the preceding claims 1 to 5 in which the guide extends in use substantially the whole length of the borehole and carries the anchor at its relatively inner end.
8. An indicator according to claim 7 in which the guide is provided with fixing anchors at or in the vicinity of its relatively outer end.
- 25 9. An indicator according to any one of the preceding claims 1 to 5 in which the guide is formed of a hollow tube provided with points of weakness.

10. An indicator according to claim 9 in which the guide is adapted for anchoring within the borehole by means of resin.
11. An indicator according to claim 9 or 10 in which the anchor is constituted by one end of the guide.
- 5 12. A strata movement indicator substantially as hereinbefore described with reference to the Figures 1 and 2, Figure 3, or Figure 4 of the accompanying drawings.

Amendments to the claims have been filed as follows

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BCC P8

CLAIMS

1. A strata movement indicator includes a flexible elongate suspension member, an anchor for anchoring the suspension member in use within a borehole formed in the strata, a guide through which the member passes, the guide being fixable in  
5 use within the borehole, and an indicator element held on the suspension member and movable in relation to the guide, the indicator element being provided with chromatic banding on its exterior surface, the movement of the element being indicative of strata movement.
- 10 2. An indicator according to claim 1 in which the flexible elongate member is a wire cable.
3. An indicator according to claim 1 or 2 in which the anchor comprises a wire torsion-spring.
4. An indicator according to any one of the preceding claims  
15 in which the indicator element is in the form of a cylinder slidable within the guide.
5. An indicator according to any one of the preceding claims in which the guide is a tubular sleeve split longitudinally.
6. An indicator according to any one of the preceding claims 1  
20 to 4 in which the guide extends in use substantially the whole length of the borehole and carries the anchor at its relatively inner end.
7. An indicator according to claim 6 in which the guide is provided with fixing anchors at or in the vicinity of its  
25 relatively outer end.
8. An indicator according to any one of the preceding claims 1 to 4 in which the guide is formed of a hollow tube provided with points of weakness.

9. An indicator according to claim 8 in which the guide is adapted for anchoring within the borehole by means of resin.
10. An indicator according to claim 8 or 9 in which the anchor is constituted by one end of the guide.
- 5 11. A strata movement indicator substantially as hereinbefore described with reference to the Figures 1 and 2, Figure 3, or Figure 4 of the accompanying drawings.

- 11 -

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

9105296.9

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|---|---|
| <p><b>Relevant Technical fields</b></p> <p>(i) UK CI (Edition ) GIM, GIS</p> <p>(ii) Int CI (Edition ) G01B</p> <p><b>Databases (see over)</b></p> <p>(i) UK Patent Office</p> <p>(ii) ONLINE DATABASES WPI</p> | <p><b>Search Examiner</b></p> <p>G HEMSLEY</p> <hr/> <p><b>Date of Search</b></p> <p>7 MAY 1991</p> |
|---|---|

Documents considered relevant following a search in respect of claims

1-12

| Category<br>(see over) | Identity of document and relevant passages | Relevant to<br>claim(s) |
|------------------------|--|-------------------------|
| X, Y                   | GB 1453260 (BERGWERKSVERBAND)              | 1, 4                    |
| X, Y                   | GB 1318344 (COBB-SLATER)                   | 1, 4                    |
| Y                      | US 4514905 (LUTZENS)                       | 1                       |
| Y                      | US 3538608 (BRONSON)                       | 1                       |

| Category | Identity of document and relevant passages | Relevant to claim(s) |
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